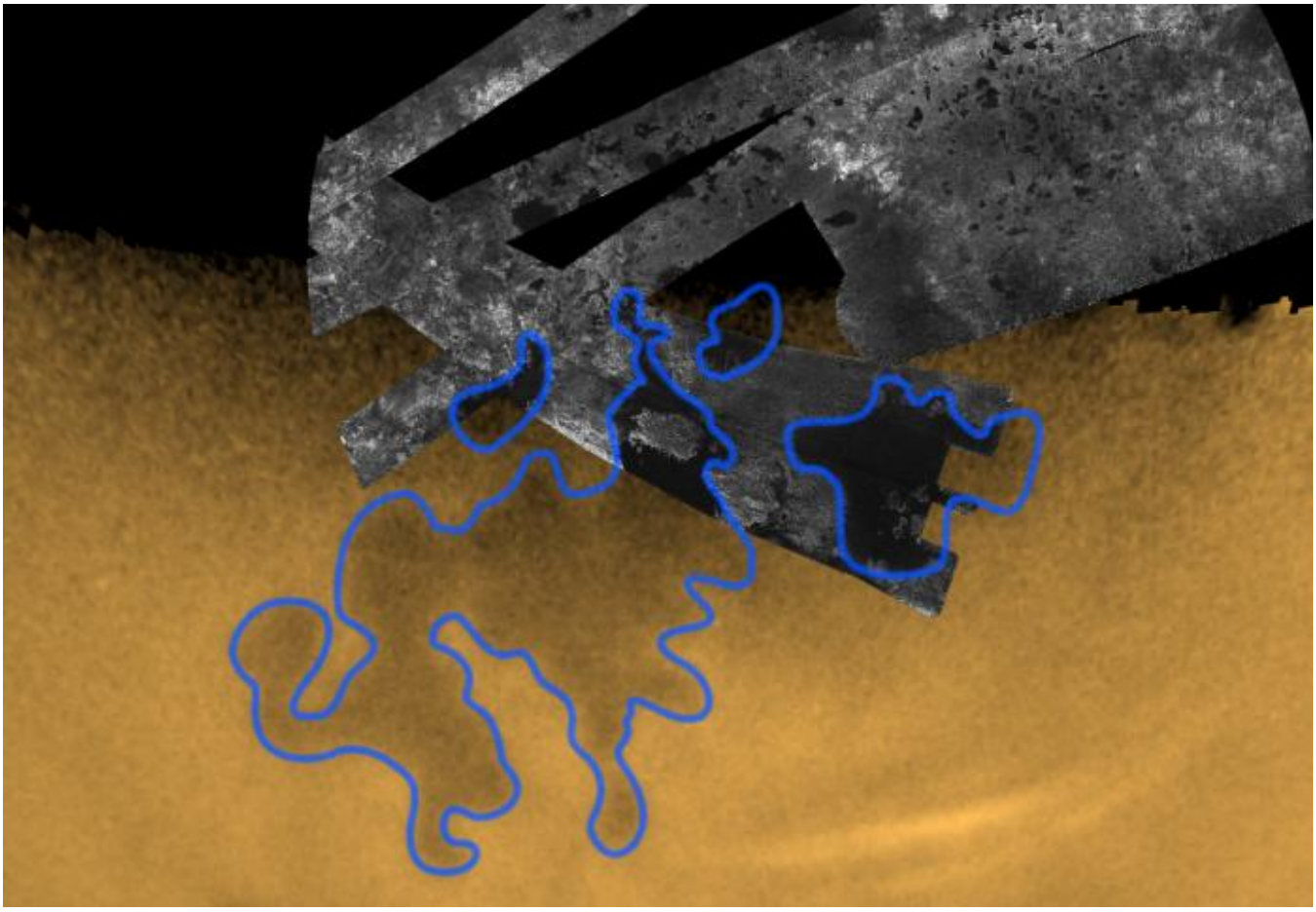
C A S S I N I



T I T A N **0 4 3 T I (T 2 9)** MISSION DESCRIPTION

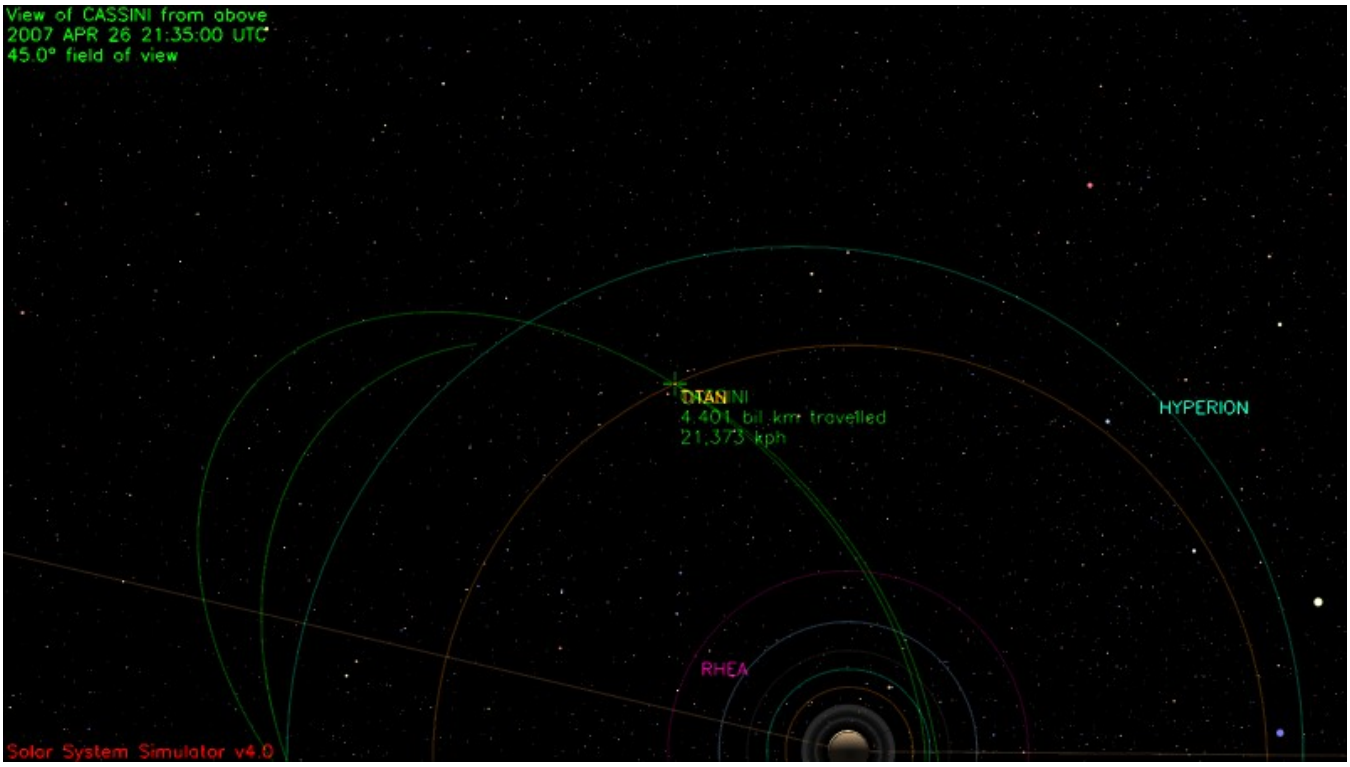
April 2007

Jet Propulsion Laboratory
California Institute of Technology

1.0 OVERVIEW

Sixteen days after Cassini's Titan-28 flyby, the spacecraft revisits Titan for its thirtieth targeted encounter. The closest approach to Titan occurs on Thursday, April 26, at 2007-116T21:32:58 spacecraft time at an altitude of 980 kilometers (~609 miles) above the surface and at a speed of 6.2 kilometers per second (13,870 mph). The latitude at closest approach is 59.7 degrees N and the encounter occurs on orbit number 43.

This encounter is set up with two maneuvers: an apoapsis maneuver on April 18, and a Titan approach maneuver, scheduled for April 23. This is the fifth in a series of outbound Titan encounters (until T34), and occurs about two days after Saturn closest approach



1.1 ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.2 TITAN-29 SCIENCE HIGHLIGHTS

- RADAR will perform observations of high latitude dark terrain. The team is particularly interested in learning how topography is guiding the wind, and identifying the orientation of the dunes. The inbound T29 RADAR observations will include mid latitude scatterometry of unique terrain coverage of Titan, altimetry, and low resolution SAR imaging. During the actual closest approach flyby, RADAR will conduct high resolution SAR imaging, filling in some of the white "gap" in RADAR observations of the lake region. The outbound leg observations will include low resolution SAR imaging, altimetry, and mid latitude scatterometry and radiometry of unique terrain coverage of Titan.
- CIRS will obtain a surface temperature map of a region in Titan's southern hemisphere, and will do limb mapping for hydrocarbons. Observations will yield information on surface & tropopause temperatures, and on the prevalence of tropospheric CH4. On the outbound leg of the encounter, CIRS will be looking for information on the thermal structure of Titan's stratosphere.
- ISS will obtain a global map with resolution of 1 km/pixel, and will perform monitoring of the disk at 1.5 km/pixel at low solar phase angles. As in the previous Titan encounter, the ISS team will be monitoring for changes in the surface and atmosphere. Scientists will attempt to see if there are any surface color variations, and will monitor limb hazes at a resolution of 1-3 km/pixel.
- VIMS will obtain phase angle coverage of the northern hemisphere.

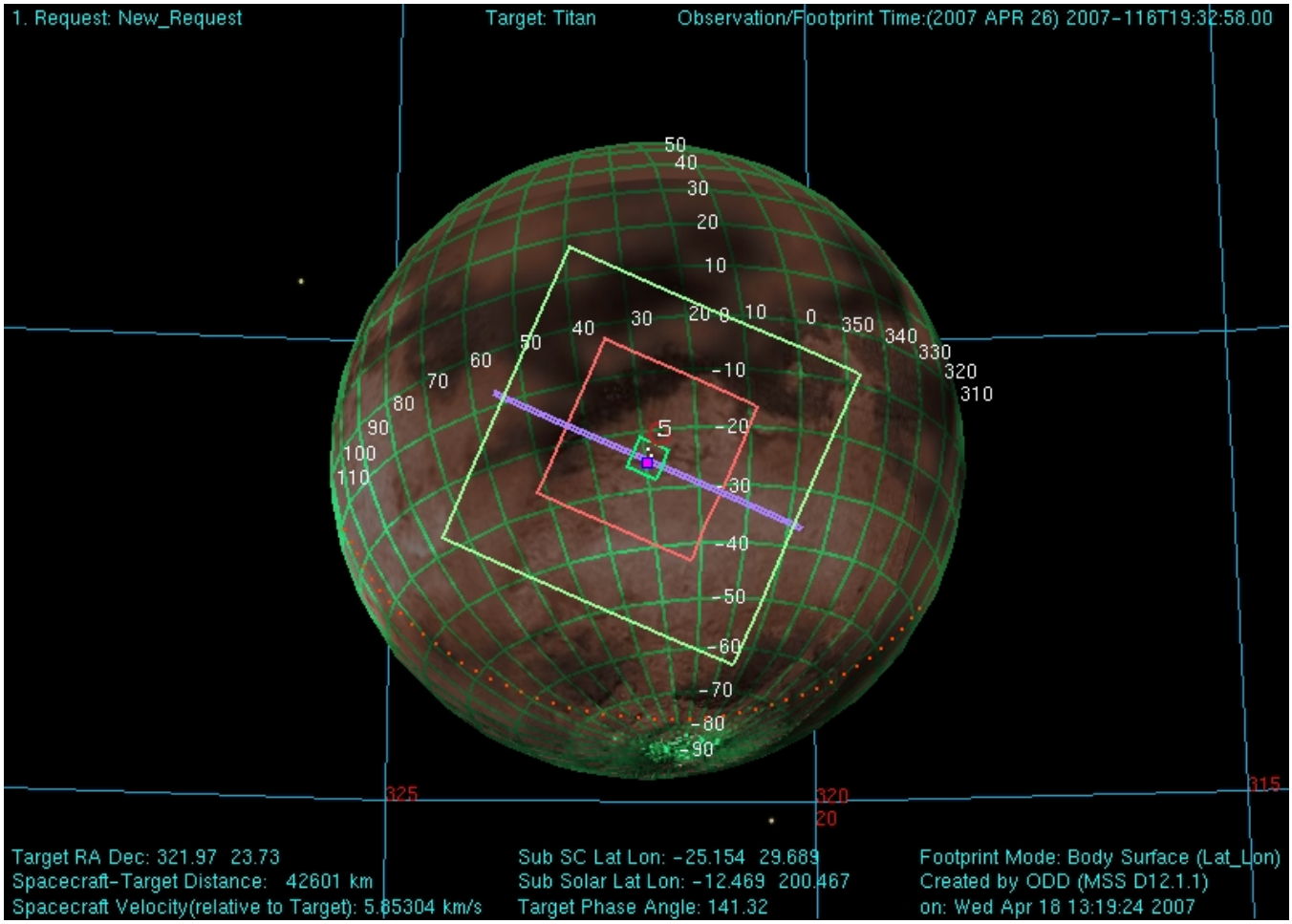
1.3 SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

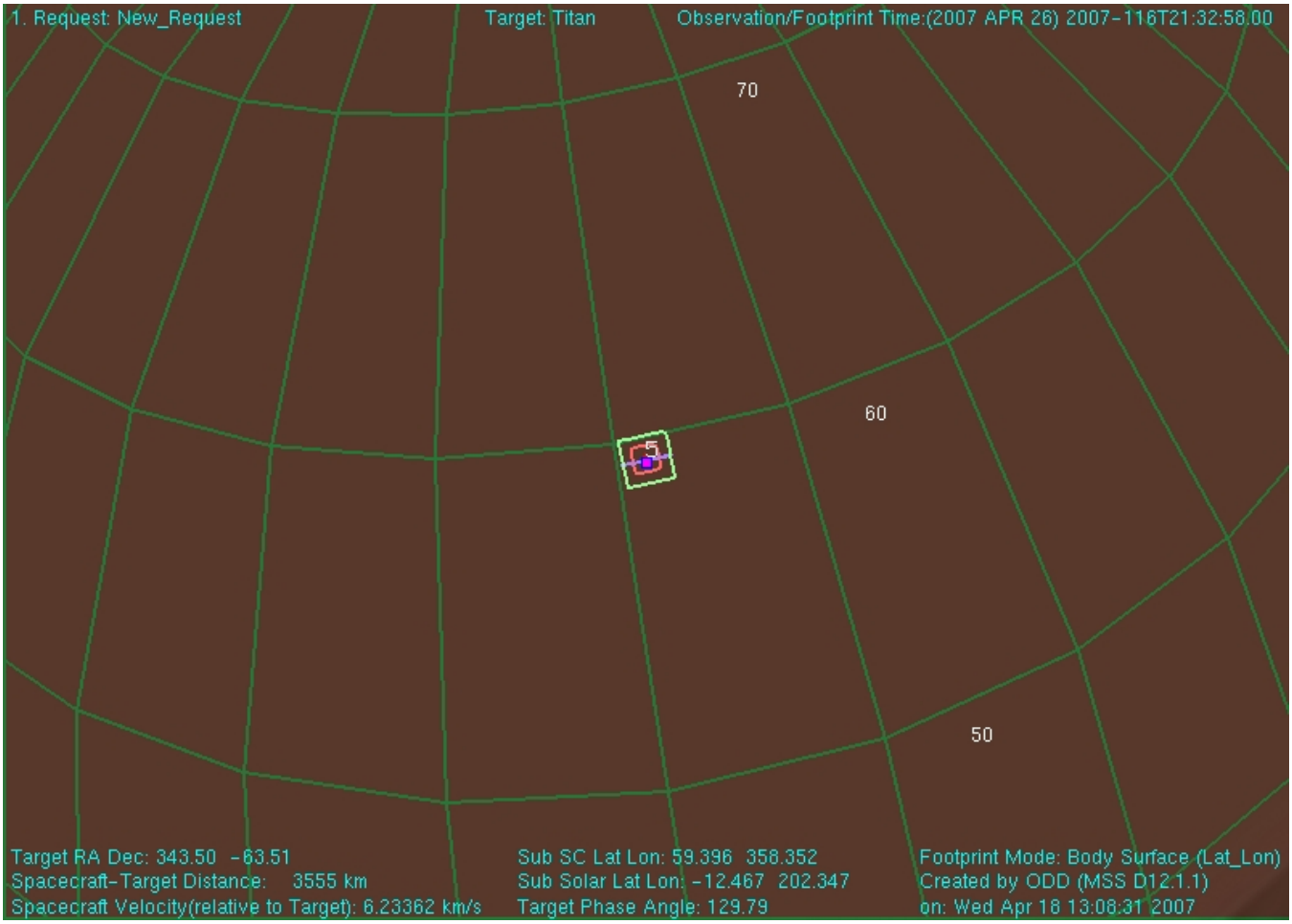
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

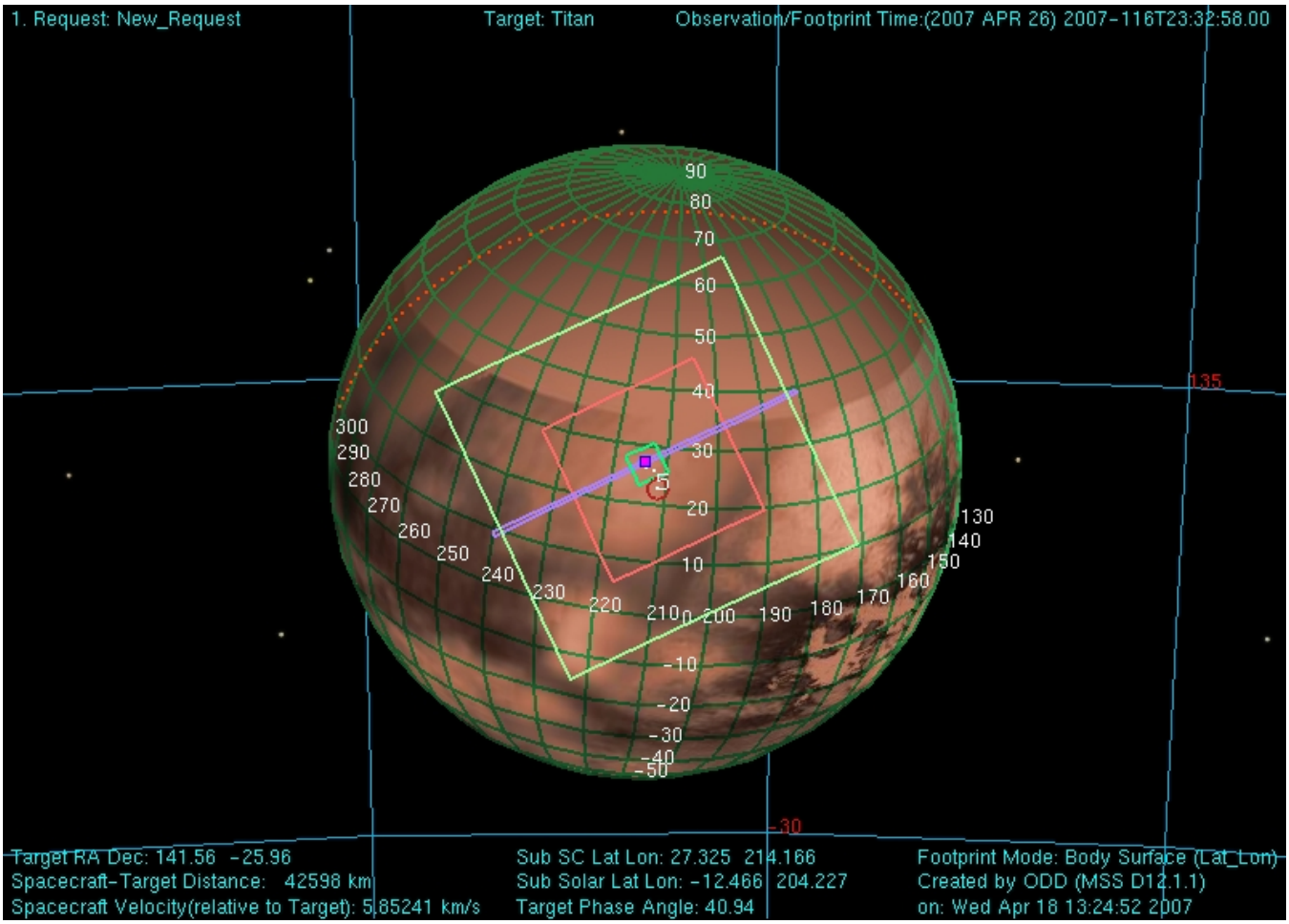
View of Titan from Cassini two hours before Titan-29 closest approach



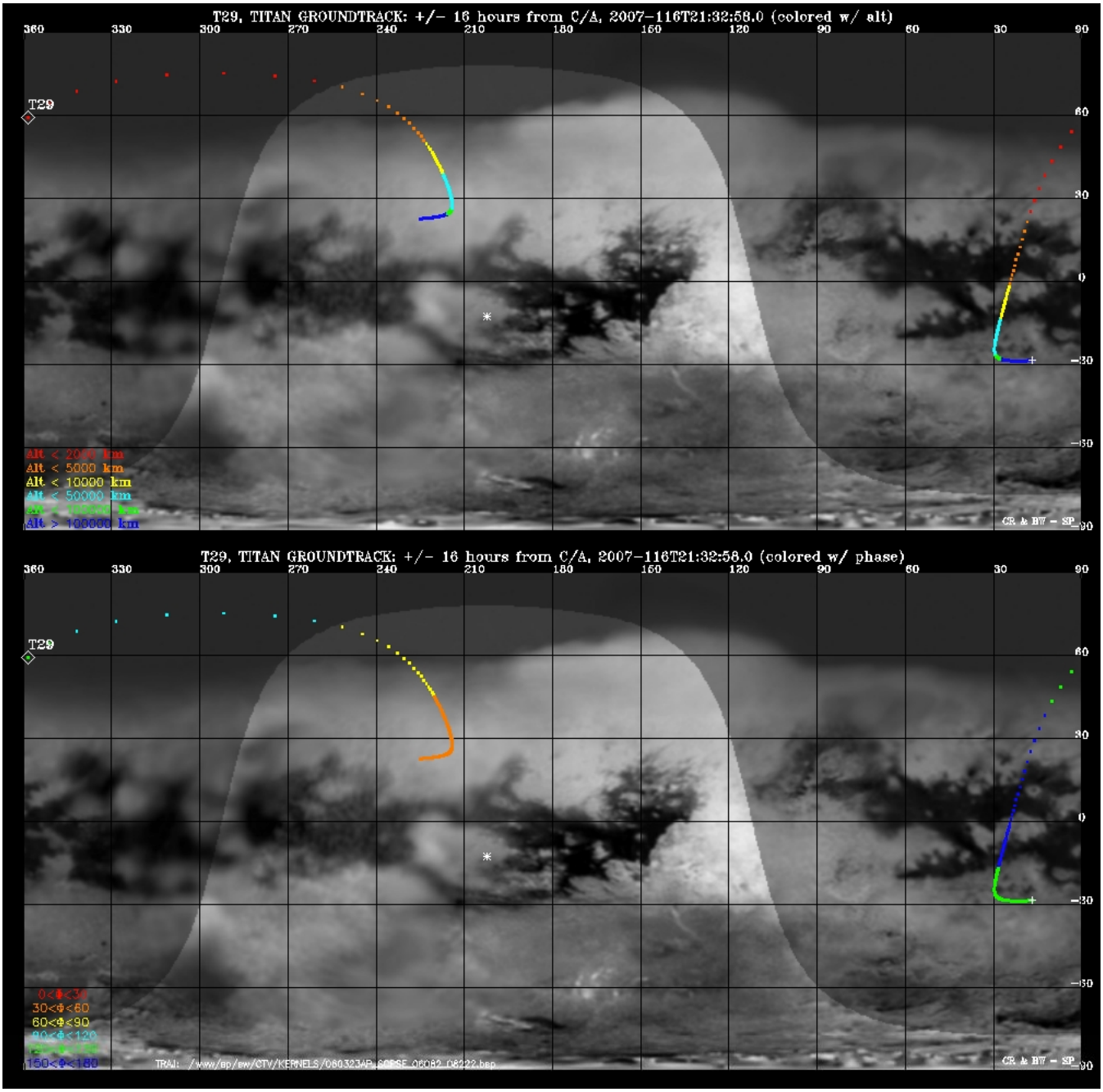
View of Titan from Cassini at Titan-29 closest approach



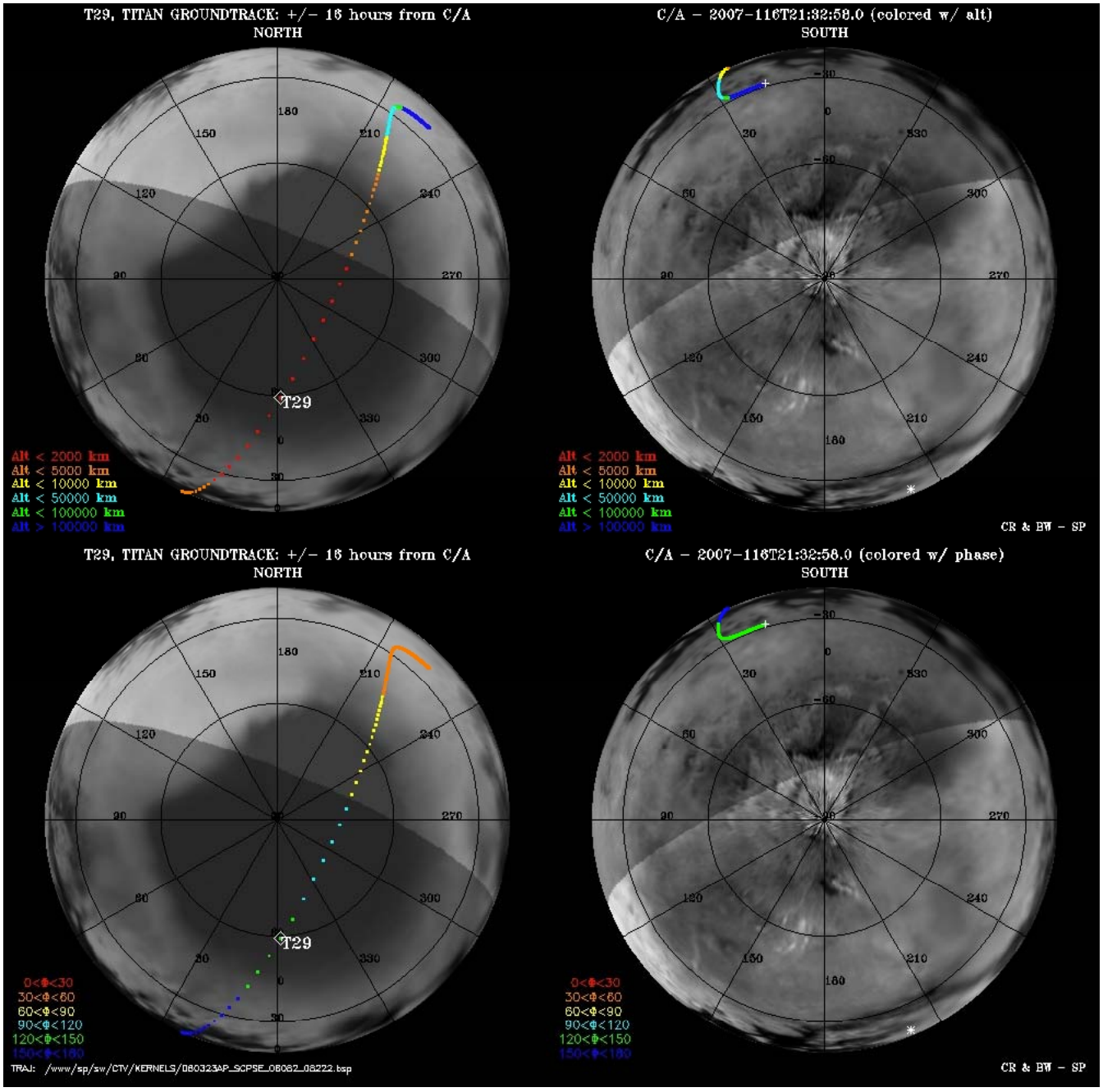
View of Titan from Cassini two hours after Titan-29 closest approach



Titan Groundtracks for T29: Global Plot



Titan Groundtracks for T29: Polar Plot



The T29 timeline is as follows:

Cassini Titan-29 Timeline - April 2007

Colors: yellow = maneuvers; blue = geometry; pink = T29-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T29	Activity	Description
087T08:04:00	Mar 28 09:18	Wed Mar 28 01:18 AM	T28-29d13h	Start of Sequence S29	Start of Sequence which contains Titan-29
113T21:16:00	Apr 23 22:30	Mon Apr 23 02:30 PM	T28-03d00h	OTM #106 Prime	Titan-29 targeting maneuver.
114T13:53:40	Apr 24 15:07	Tue Apr 24 07:07 AM	T28-02d08h	Descending Ring Plane Crossing	
114T20:02:44	Apr 24 21:16	Tue Apr 24 01:16 PM	T28-02d02h	Saturn Periapse	Saturn periapse, R = 5.7 Rs, lat = -32 deg, phase = 107 deg
114T21:01:00	Apr 24 22:15	Tue Apr 24 02:15 PM	T28-02d01h	OTM #106 Backup	
116T06:01:00	Apr 26 07:15	Wed Apr 25 11:15 PM	T28-15h31m	Start of the TOST segment	
116T06:01:00	Apr 26 07:15	Wed Apr 25 11:15 PM	T28-15h31m	Turn cameras to Titan	
116T06:31:00	Apr 26 07:45	Wed Apr 25 11:45 PM	T28-15h01m	Deadtime	15 minutes 58 seconds long; used to accommodate changes in flyby time
116T06:46:58	Apr 26 08:00	Thu Apr 26 12:00 AM	T28-14h46m	Titan atmospheric Observations	Mid-IR Temperature Map
116T11:32:58	Apr 26 12:46	Thu Apr 26 04:46 AM	T28-10h00m	ISS Imaging	Photometry
116T12:32:58	Apr 26 13:46	Thu Apr 26 05:46 AM	T28-09h00m	Titan atmospheric Observations	VIMS regional cloud Map
116T16:32:58	Apr 26 17:46	Thu Apr 26 09:46 AM	T28-05h00m	Titan surface and atmospheric observations	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
116T19:42:58	Apr 26 20:56	Thu Apr 26 12:56 PM	T28-01h50m	New Waypoint	
116T19:42:58	Apr 26 20:56	Thu Apr 26 12:56 PM	T28-01h50m	RADAR Observations	Mid latitude scatterometry of unique terrain coverage of Titan.
116T20:40:58	Apr 26 21:54	Thu Apr 26 01:54 PM	T28-00h52m	Transition to Thruster Control	
116T21:02:58	Apr 26 22:16	Thu Apr 26 02:16 PM	T28-00h30m	RADAR Observations	Altimetry measurements on the inbound leg of the T28 flyby.
116T21:10:40	Apr 26 22:24	Thu Apr 26 02:24 PM	T28-00h22m	Solar Occultation	22 minute duration
116T21:12:14	Apr 26 22:26	Thu Apr 26 02:26 PM	T28-00h20m	Earth Occultation	21 minute duration
116T21:16:58	Apr 26 22:30	Thu Apr 26 02:30 PM	T28-00h16m	RADAR Observations	Low resolution SAR imaging on the inbound leg of T28.
116T21:25:58	Apr 26 22:39	Thu Apr 26 02:39 PM	T28-00h07m	RADAR Observations	High resolution SAR imaging during the T28 closest approach period
116T21:32:58	**Apr 26 22:46**	**Thu Apr 26 02:46 PM**	**T28+00h00m**	**Titan-29 Flyby Closest Approach Time**	**Altitude = 980 km (608 miles), speed = 6.2 km/s (13,870 mph); 130 deg phase at closest approach**
116T21:35:04	Apr 26 22:49	Thu Apr 26 02:49 PM	T28+00h03m	Ascending Ring Plane Crossing	
116T21:39:58	Apr 26 22:53	Thu Apr 26 02:53 PM	T28+00h07m	RADAR Observations	Low resolution SAR imaging on the outbound leg of T29.
116T21:48:58	Apr 26 23:02	Thu Apr 26 03:02 PM	T28+00h16m	RADAR Observations	Altimetry
116T22:02:58	Apr 26 23:16	Thu Apr 26 03:16 PM	T28+00h30m	Transition off of Thruster Control	
116T22:24:39	Apr 26 23:38	Thu Apr 26 03:38 PM	T28+00h52m	RADAR Observations	Mid latitude scatterometry
116T22:49:58	Apr 27 00:03	Thu Apr 26 04:03 PM	T28+01h17m	RADAR Observations	Radiometry observations
117T02:23:00	Apr 27 03:37	Thu Apr 26 07:37 PM	T28+04h51m	New Waypoint	
117T02:42:58	Apr 27 03:56	Thu Apr 26 07:56 PM	T28+05h10m	Titan regional map	
117T05:32:58	Apr 27 06:46	Thu Apr 26 10:46 PM	T28+08h00m	ISS Imaging	Global map
117T06:12:58	Apr 27 07:26	Thu Apr 26 11:26 PM	T28+08h40m	ISS Imaging	Photometry
117T06:32:58	Apr 27 07:46	Thu Apr 26 11:46 PM	T28+09h00m	Titan atmospheric Observations	Obtain information on CO, HCN, CH4
117T08:32:58	Apr 27 09:46	Fri Apr 27 01:46 AM	T28+11h00m	ISS Imaging	Monitoring of surface and atmosphere
117T10:32:58	Apr 27 11:46	Fri Apr 27 03:46 AM	T28+13h00m	Titan regional map	
117T11:32:58	Apr 27 12:46	Fri Apr 27 04:46 AM	T28+14h00m	Titan atmospheric Observations	Obtain information on the thermal structure of Titan's stratosphere.
117T12:14:58	Apr 27 13:28	Fri Apr 27 05:28 AM	T28+14h42m	Deadtime	15 minutes two seconds long; used to accommodate changes in flyby time
117T12:30:00	Apr 27 13:44	Fri Apr 27 05:44 AM	T28+14h58m	Turn to Earth-line	
117T13:00:00	Apr 27 14:14	Fri Apr 27 06:14 AM	T28+15h28m	Playback of T29 Data	Madrid 70M